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# **Modeling and Simulation Applications on the Global Information Grid**

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# Purpose

- **To examine the ways in which modeling and simulation (M&S) can be integrated into the Global Information Grid (GIG) to provide enhanced capabilities to GIG participants.**



# Introduction

- **The Global Information Grid (GIG) is:**
  - **Major Restructuring of DoD Communications and Information Infrastructure**
  - **Implementation of Net-centric Warfare Concept**
  - **Modeled on Internet**
  - **Major Opportunity for M&S to Support Operating Forces**



# GIG Architecture

- **Consolidation of separate protocols and media into integrated backbone**
  - Network
  - Broadcast
  - Point to point
- **Medium is Transparent to User**
- **Use of Internet Protocol (IP V-6) and Web Services to Exchange Data**

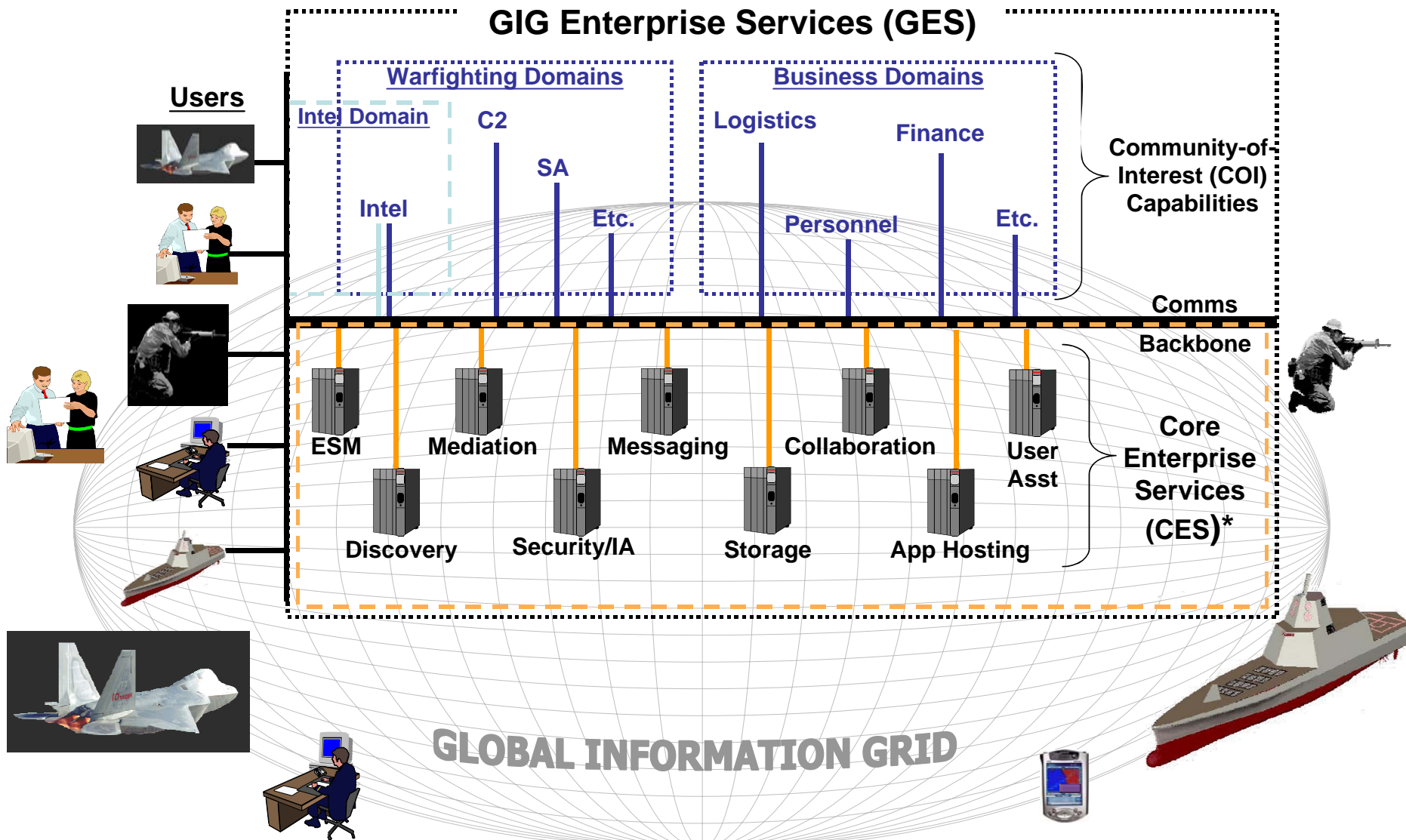


# **GIG Architecture (Ctd.)**

- **The GIG is:**
  - **An Integrated, Scalable, Fully Distributed Processing and Transport Environment**
  - **Based on Commercial Technology**
- **GIG Capabilities include:**
  - **Move data from any source to any destination**
  - **Tailored Information—"Intelligent Pull"**
  - **Integrates Legacy Systems**
  - **Exploits sensor, weapon and platform capabilities**



# GIG Architecture (Ctd.)



**Scale: Several Million Users; Tens of Thousands of Information Services**

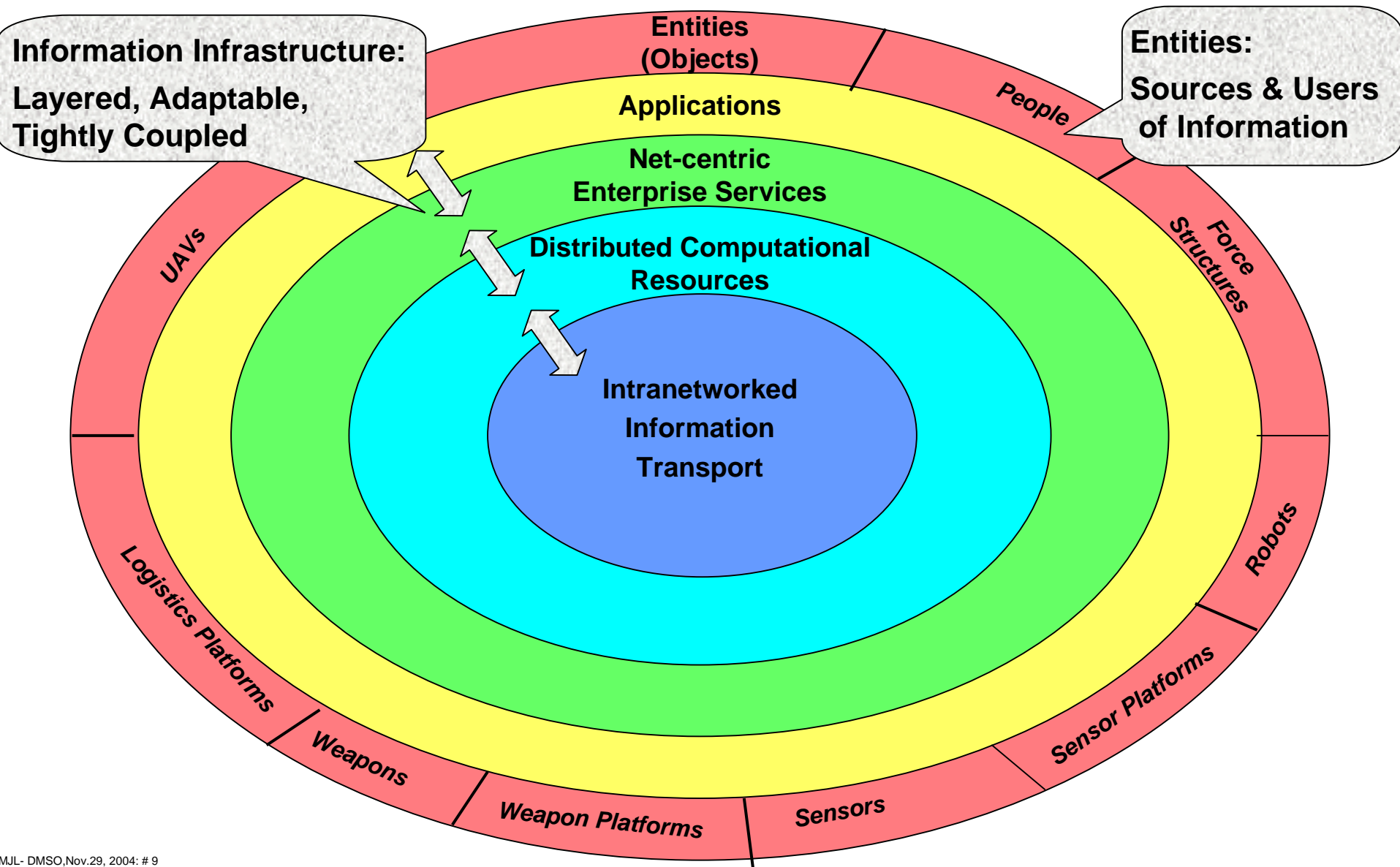


# Net-centric Warfare on the GIG

- **Ensure Data are Visible, Accessible & Understandable**
- **Tag with Metadata to Facilitate Discovery**
- **Post Data to Shared Spaces**
- **Organize around Communities of Interest (COIs)**



# Net-centric Warfare on the GIG



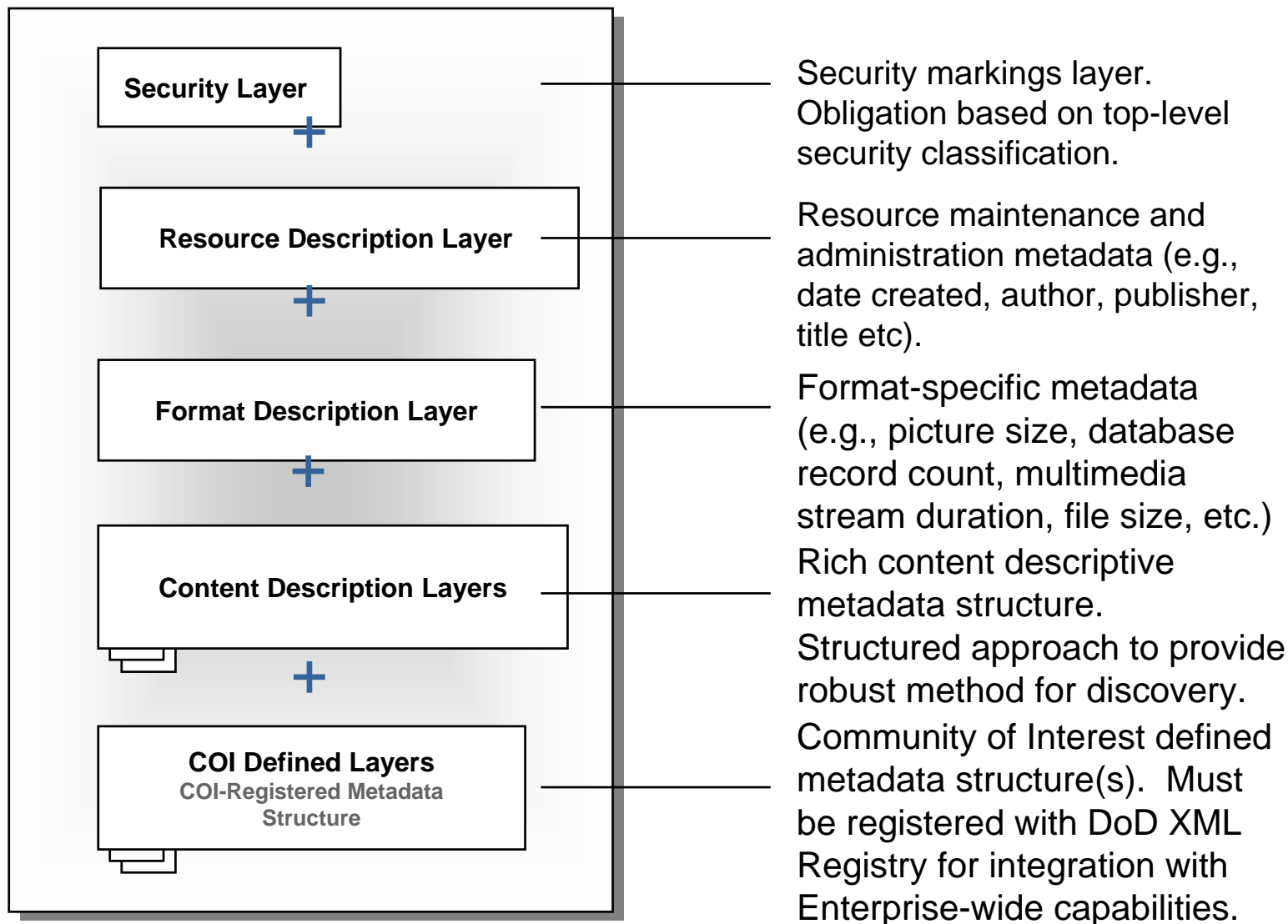


# DoD Net-centric Data Strategy

- **Ensuring that data are visible, accessible and understandable**
- **Tagging with metadata to enable discovery**
- **Posting data to shared spaces**
- **Organizing around Communities of Interest (COIs)**



# DoD Net-centric Data Strategy (Ctd.)





# GIG Implementation

- **Internet Protocol (Version 6)**
- **GIG Bandwidth Expansion (GIG-BE)**
- **Transformational Communications System**
- **GIG Information Assurance**



# GIG M&S Implementation

- **By Technique**
  - Live
  - Virtual
  - Constructive
- **By Application**
  - Analysis
  - Test and Evaluation
  - Training
  - Operations Planning
- **Within Internet Context**
  - Local
  - Remote
  - Distributed
- **Model Elements**
  - Data Set
  - Algorithm
  - Operating System
  - Communications  
(input/output or I/O)

***For the purposes of this paper, we will consider models and simulations in terms of the Internet Context***



# M&S Implementation Terminology

- **Local—Functionality Resident in Controlling Processor**  
Base Case is “Stand-alone” when all functionalities resident in one processor
- **Remote—Functionality Resident in non-local Processor**
- **Distributed—Functionality Resident in Multiple Processors**



# GIG M&S Techniques

- **Evolution Process**
  - Standalone
  - Dedicated Network
  - Local Area Network (LAN)
  - Internet and GIG (Internet Protocol)
- **GIG Processes**
  - Remote Processing and Data Acquisition
  - Distributed Simulation

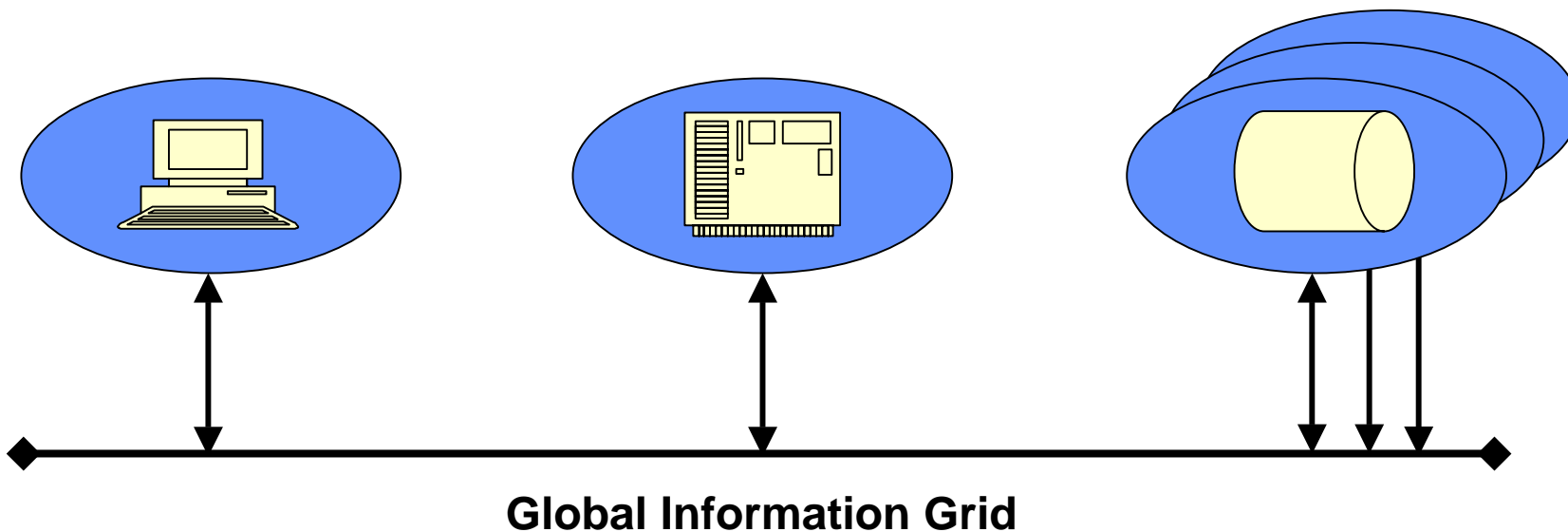


# Internodal Diagram— Remote Processing and Data Acquisition

Local User

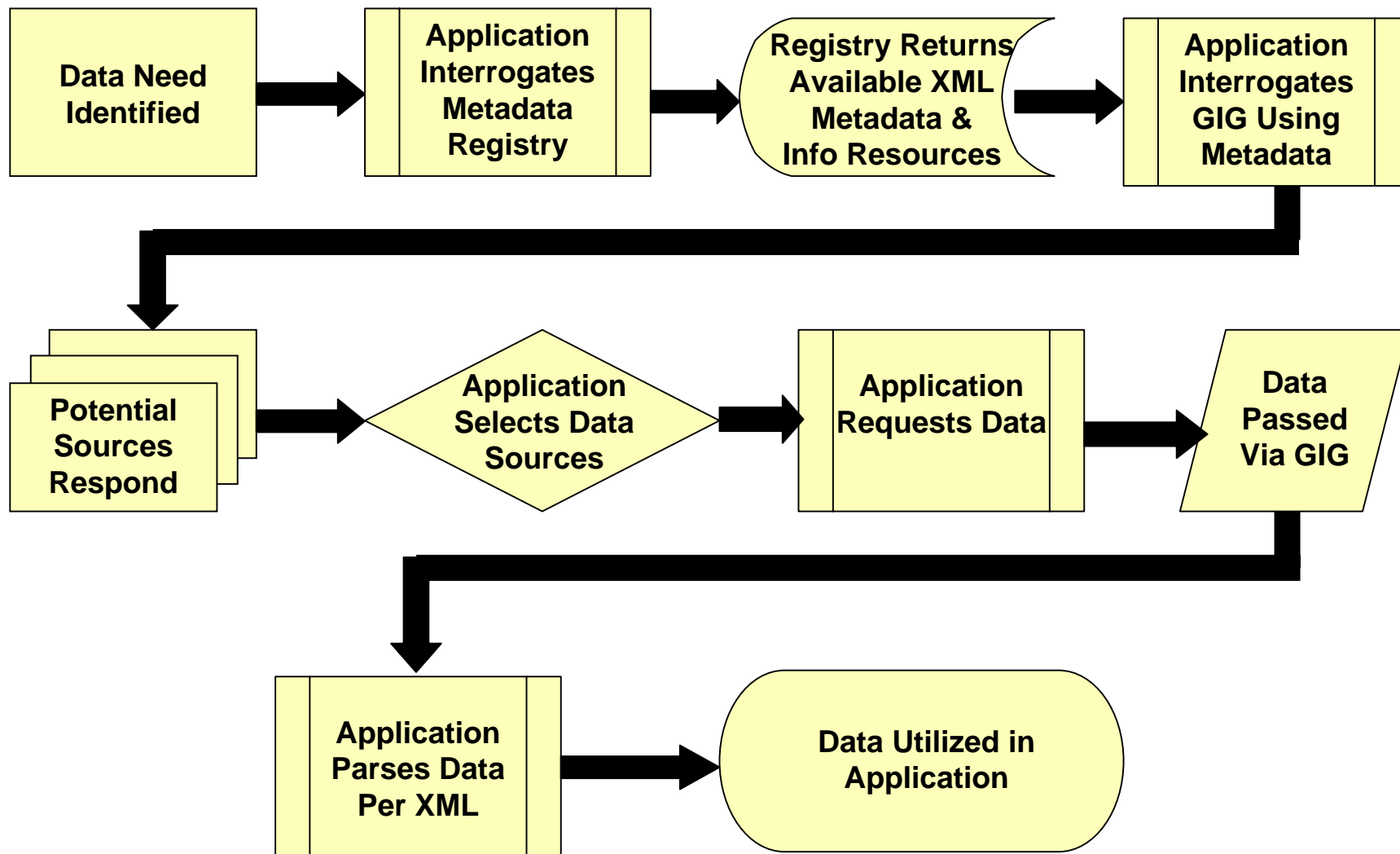
Remote Processor

Remote Data





# Remote Data Acquisition Process





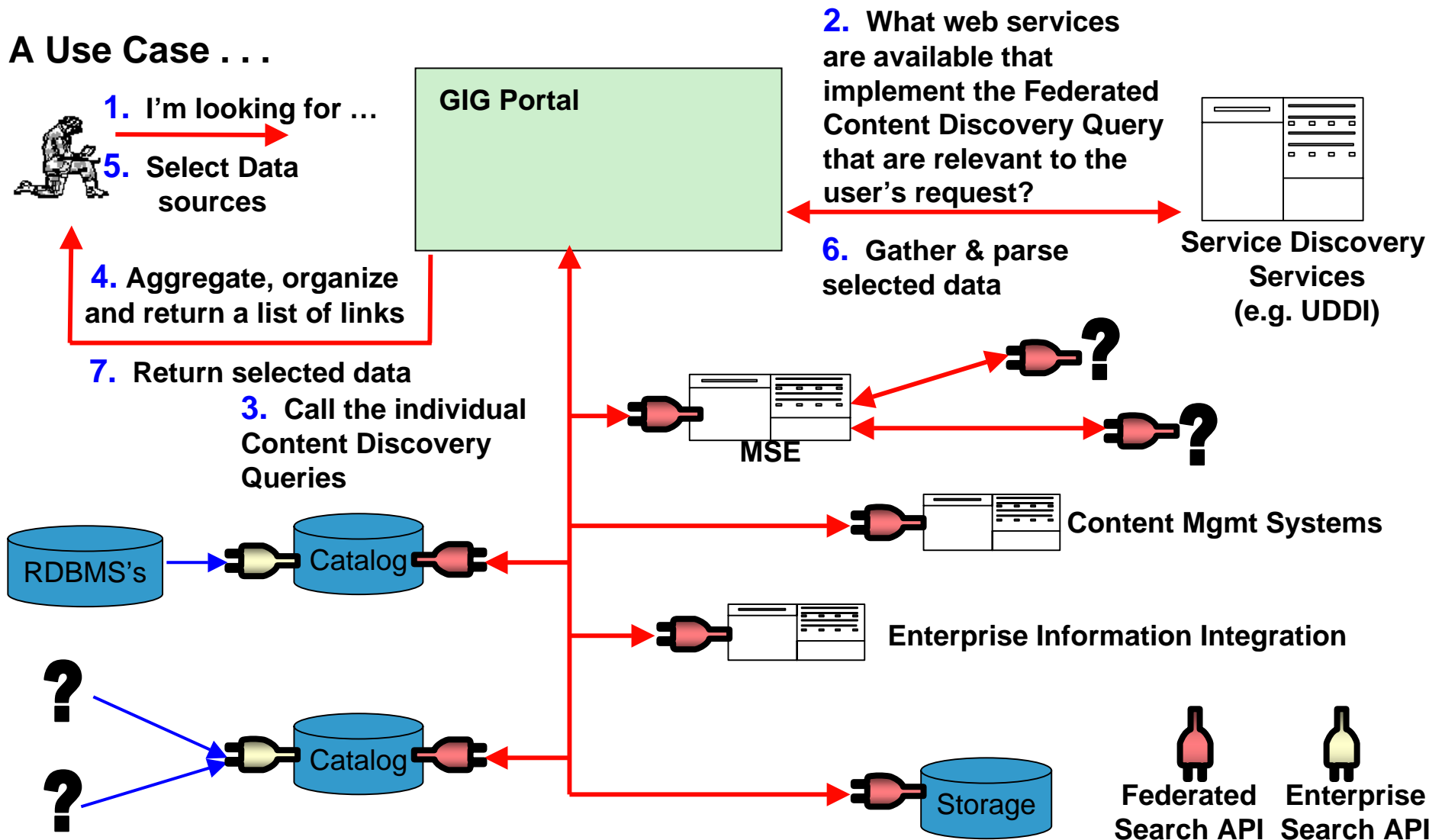
# Remote Data Acquisition

- **DoD Implementation**
  - **Metadata Guided Search**
  - **Data Discovery**
  - **Parsing for Retrieval**



# Remote Data Acquisition

## A Use Case . . .





# Remote Data Acquisition

- **Examples**
  - **Accessing reference data**
  - **Accessing classified sources**
  - **Interrogating multiple sources**
- **Benefits**
  - **Timeliness of data and turn-around**
  - **Speed of set-up, execution and analysis**
  - **Accuracy--Authoritative Sources Selection**
  - **Reduced Reply Bandwidth Requirements**

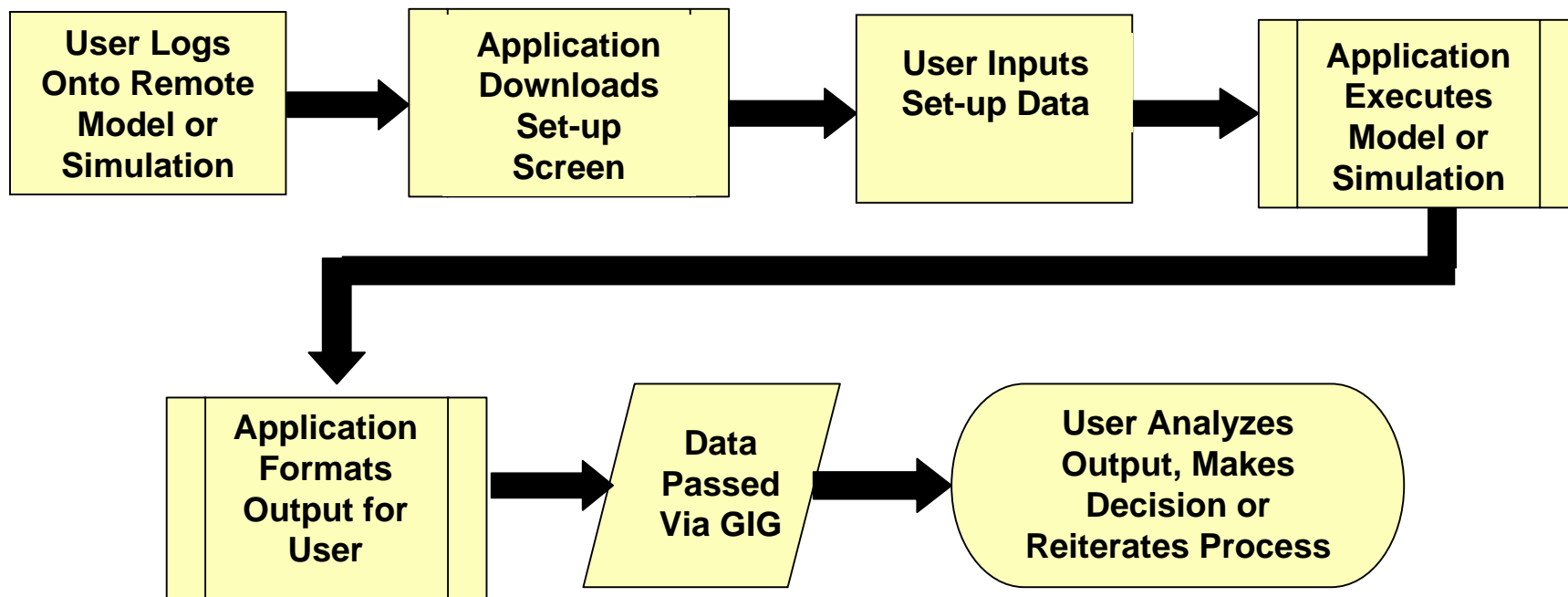


# Remote Execution Process

- **One Data Processor Accesses Another**
  - **Initializes and Executes a Program**
  - **May Involve Remote Data Sources**
  - **Minimum Data Exchange**



# Remote Execution Process





# Remote Execution Process

- **Examples**

- **Purchases Made Over the Internet**
- **Accessing Scientific & Engineering Models Over the Internet**
- **Internet Email Access**

- **Benefits**

- **Ability to Utilize Remote Sources**
- **Program Owner Can Maintain Software Without Need for Mass Distribution**
- **Control Over Input Data**
- **Minimum Processor Requirement for Remote Users**



# Distributed Simulation Execution

- **Data Exchange Medium and Protocol**
  - **Ensure Connectivity**
  - **Prevent Data Latency from Affecting Solution**
- **Execution Control Medium and Protocol**
  - **Sequencing**
  - **Prevent Control from Influencing Solution**
- **Synchronization via Master Clock**
  - **GPS for Real Time**
  - **Event Time Control**



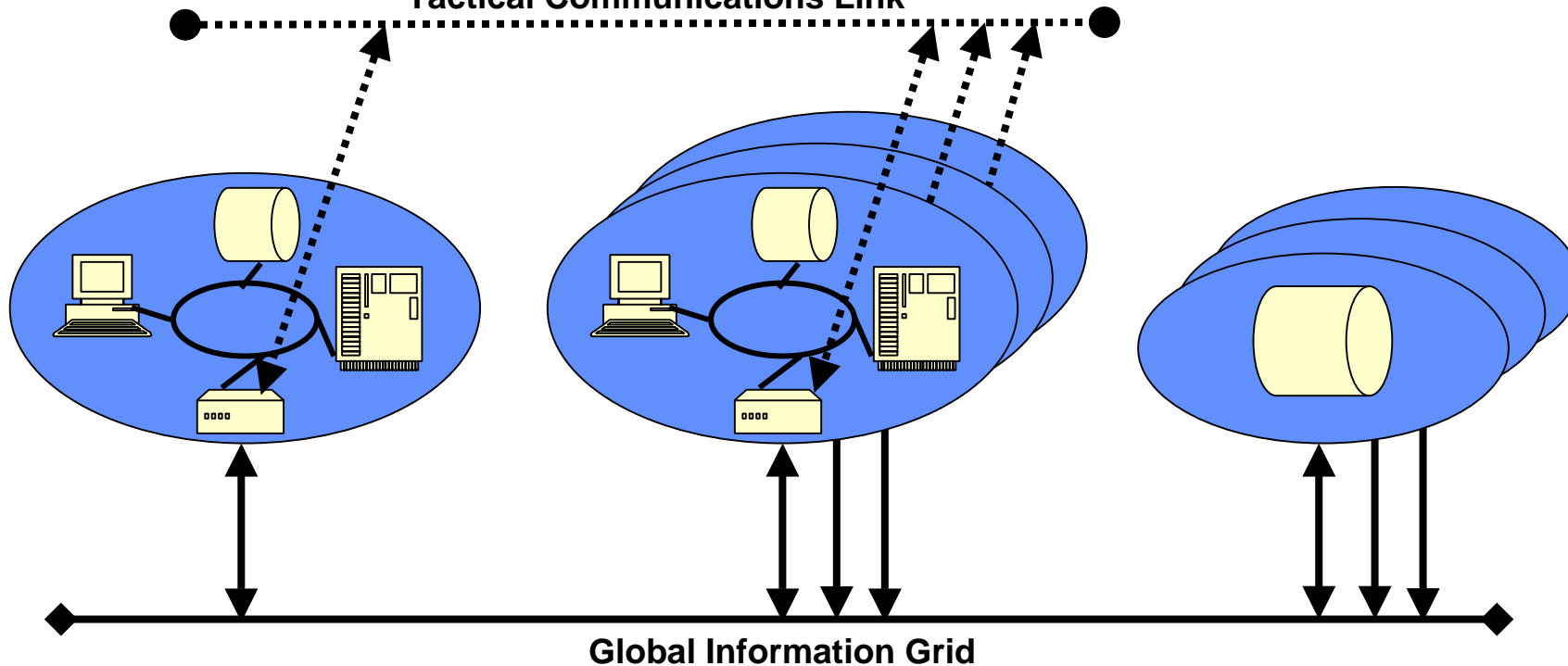
# Internodal View— Distributed Simulation Execution

Master Federate

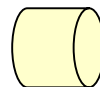
Distributed Federates

Distributed Data Sources

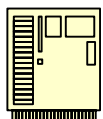
Tactical Communications Link



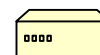
Work Stations (May, or may not, be at specific distributed federates)



Mass Data Storage (May, or may not, be at specific distributed federates)



Main Frame or Tactical Data Processor



Communications Suite--  
Routers/Modems/Tactical Radios

GIG Network



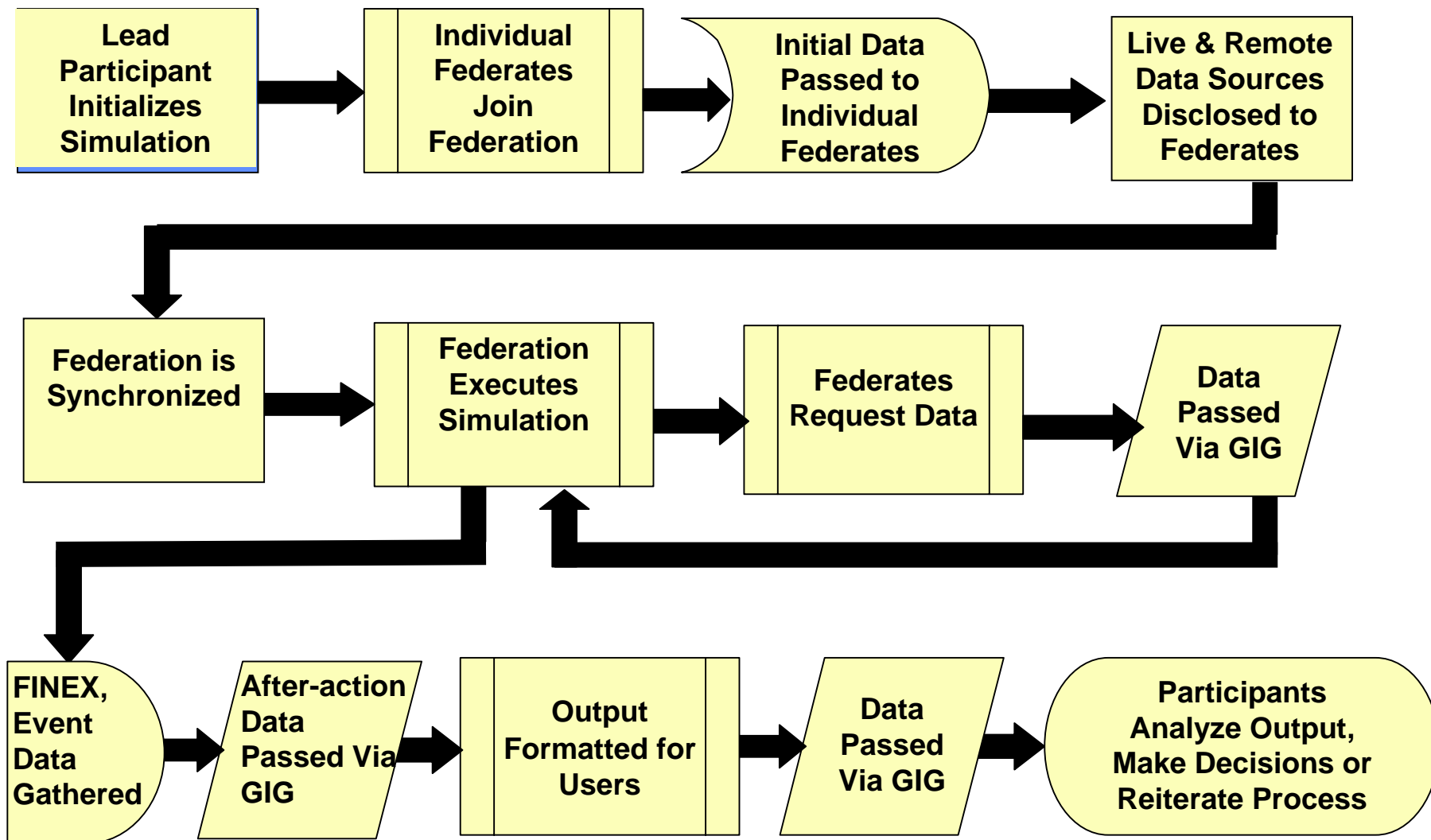
Local Area  
Network (LAN)



Tactical Communications Link  
(Selected Federates Only)



# Distributed Execution Process





# M & S Applications

- **Remote Data Acquisition**

- **Access**

- ◆ Reference/Authoritative Data Sets
    - ◆ Classified Data—Secure Connections
    - ◆ Utilize Multiple Sources

- **Advantages**

- ◆ Improved Timeliness
    - ◆ Faster—Set-up, Execution & Analysis
    - ◆ Increased Accuracy—Better Data
    - ◆ More Efficient Use of Bandwidth



# M & S Applications (Ctd.)

- **Remote Execution**

- **Access**

- ◆ More Complex M&S Applications
    - ◆ Larger Processors

- **Advantages**

- ◆ Security of Data and M&S Application
    - ◆ Standardization/Configuration Control
    - ◆ Reduced Field Unit Processor Requirements
    - ◆ Smaller Software Load for Remote Users



# M & S Applications (Ctd.)

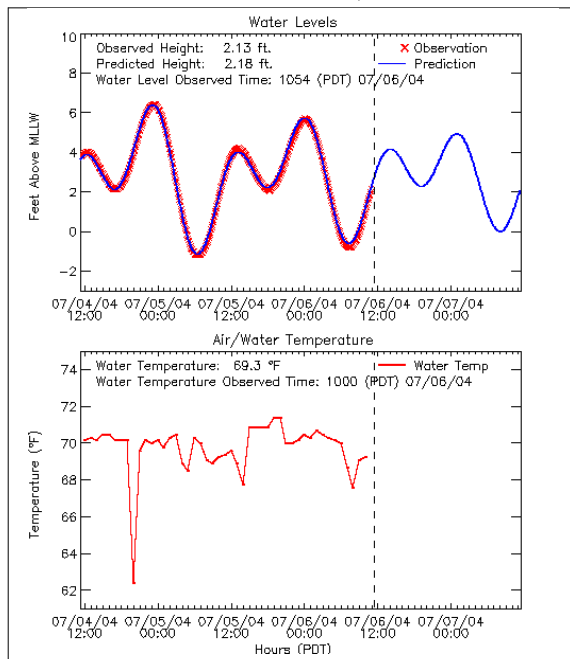
## • Remote Execution Example

### NOAA On-line Tide Model

#### A. Executed for Current/Historical Data

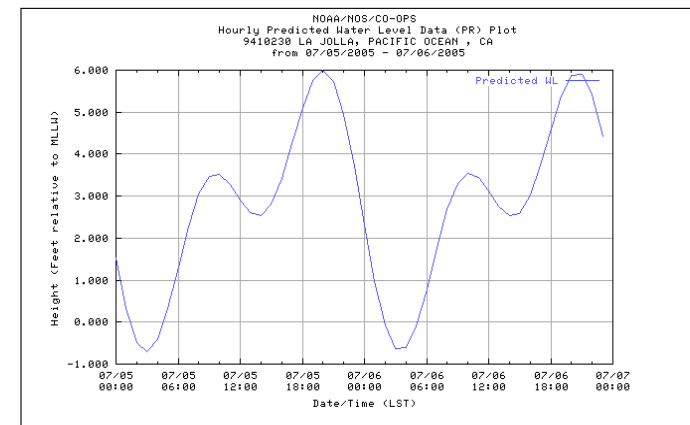
#### B. Executed for Future Conditions

9410230 La Jolla, CA



(Water level data is referenced to MLLW)

Date/Time	Pre.	Obs.	Res.	Wsp.	Wdr.	Wgt.	Bar.	Air	Water
(Local Time)	(ft.)	(ft.)	(ft.)	(kts.)	(true)	(kts.)	(mb.)	(°F)	(°F)
07/04/2004 11:24:00 PDT	3.69	3.79	0.10	-999	-999	-999	-999.9	-99.9	-99.9
07/04/2004 11:30:00 PDT	3.74	3.85	0.11	-999	-999	-999	-999.9	-99.9	-99.9
07/04/2004 11:36:00 PDT	3.78	3.86	0.08	-999	-999	-999	-999.9	-99.9	-99.9
■ ■ ■									
07/07/2004 11:06:00 PDT	1.89	-99.99	-99.99	-999	-999	-999	-999.9	-99.9	-99.9
07/07/2004 11:12:00 PDT	1.98	-99.99	-99.99	-999	-999	-999	-999.9	-99.9	-99.9
07/07/2004 11:18:00 PDT	2.09	-99.99	-99.99	-999	-999	-999	-999.9	-99.9	-99.9
07/07/2004 11:24:00 PDT	2.19	-99.99	-99.99	-999	-999	-999	-999.9	-99.9	-99.9



**Predicted Water Level Data (PR)** Station -- Unique seven character identifier for the station  
Time -- Date and time the data were collected by the DCP PR -- Predicted Water level height **Data**  
are in Feet above **MLLW** Times are on **Local Standard Time (LST)**

9410230 LA JOLLA, PACIFIC OCEAN, CA from 20050705 to 20050706

Station	Date	Time	PR	Station	Date	Time	PR	Station	Date	Time	PR
9410230	2005/07/05	00:00	1.52	9410230	2005/07/05	01:00	0.32	9410230	2005/07/05	02:00	-0.47
9410230	2005/07/05	03:00	-0.71	9410230	2005/07/05	04:00	-0.41	9410230	2005/07/05	05:00	0.33
9410230	2005/07/05	06:00	1.30	9410230	2005/07/05	07:00	2.28	9410230	2005/07/05	08:00	3.04
9410230	2005/07/05	09:00	3.47	9410230	2005/07/05	10:00	3.52	9410230	2005/07/05	11:00	3.28
9410230	2005/07/05	12:00	2.91	9410230	2005/07/05	13:00	2.61	9410230	2005/07/05	14:00	2.55
9410230	2005/07/05	15:00	2.82	9410230	2005/07/05	16:00	3.42	9410230	2005/07/05	17:00	4.24
9410230	2005/07/05	18:00	5.09	9410230	2005/07/05	19:00	5.74	9410230	2005/07/05	20:00	5.99
9410230	2005/07/05	21:00	5.73	9410230	2005/07/05	22:00	4.93	9410230	2005/07/05	23:00	3.73
9410230	2005/07/06	00:00	2.32	9410230	2005/07/06	01:00	0.97	9410230	2005/07/06	02:00	-0.07
9410230	2005/07/06	03:00	-0.63	9410230	2005/07/06	04:00	-0.62	9410230	2005/07/06	05:00	-0.10
9410230	2005/07/06	06:00	0.78	9410230	2005/07/06	07:00	1.78	9410230	2005/07/06	08:00	2.68
9410230	2005/07/06	09:00	3.30	9410230	2005/07/06	10:00	3.55	9410230	2005/07/06	11:00	3.45
9410230	2005/07/06	12:00	3.12	9410230	2005/07/06	13:00	2.75	9410230	2005/07/06	14:00	2.53
9410230	2005/07/06	15:00	2.60	9410230	2005/07/06	16:00	3.02	9410230	2005/07/06	17:00	3.73
9410230	2005/07/06	18:00	4.59	9410230	2005/07/06	19:00	5.37	9410230	2005/07/06	20:00	5.87
9410230	2005/07/06	21:00	5.90	9410230	2005/07/06	22:00	5.40	9410230	2005/07/06	23:00	4.42



# M & S Applications (Ctd.)

## • **Distributed Execution**

### **-Access**

- ◆ Multiple Processors
- ◆ Multiple Sites
- ◆ Different Operating Systems

### **-Advantages**

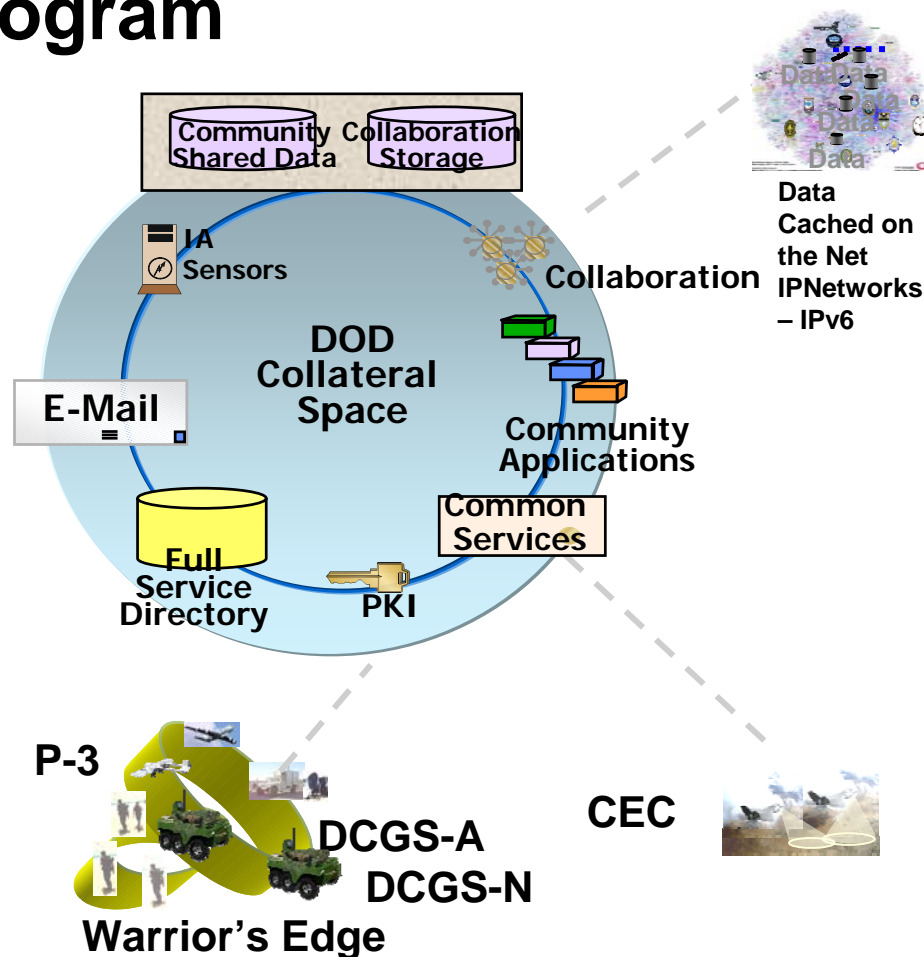
- ◆ Synchronous or Asynchronous Execution
- ◆ More Accurately Represent “Real World” Operation
- ◆ Incorporate Operational Applications/Processors.



# M & S Applications (Ctd.)

## • Distributed Execution Example - Horizontal Fusion Program

- Build-out the Collateral Space
  - ISP-like provider
  - Implement Standard Specifications
    - NCES
    - Data Mgt Strategy
- Continuously add data stores
- Implement “sense-making” applications
  - Complex pattern recognition
  - Large Data Set Visualization
  - User profiling
    - Subscription
    - Portal tailoring
    - Alerts





# M & S Applications (Ctd.)

- **Distributed Execution Example**  
- **Commercial Application [Screen Shot]**

## Welcome to : **Free Online Multiplayer Interactive Games**

The ultimate directory of free multi-player games you can play online through your web browser (Netscape, Internet Explorer, AOL browser, WebTV,...).

Hundreds of games sorted into 6 categories : strategy & war games, role-playing games, board & card games, sports games, action & fight games, other games.

All the games are **FREE to play and require no additional software to download and install on your computer!**

**FREE**

**Online**

**MULTIPLAYER**

**Interactive**

**GAMES**

### Welcome to Free Online Multiplayer Interactive Games

This site is not a general site about computer games or online gaming. It is a directory dedicated to free multi-player webgames. What's that? Well, in short :

1. The games you will find on this site are absolutely **FREE** to play. Nothing to pay, ever. Enjoy !
2. The games are all **multi-player**. The Web allows you to play with thousands of people from all over the world, so why would you want to play alone? ;-)
3. The games are designed to be played right in your **web browser**. No plug-ins are needed, and you don't need to download and install anything on your computer.



# Summary

- **Required Technology is Here Today**
- **Infrastructure is Growing to Meet Need**
- **Need to Change Current Practices**
  - **Adapt M&S as Web Service/Application**
  - **Facilitate Discovery/Increase Visibility**
- **Commercial World has Implemented Elements of All Application Types**



# The Way Ahead--Considerations

- **Data Posted for Discovery on GIG**
  - Common Metadata Throughout Community
  - Example: DoD Metadata Registry
- **Data In Machine-usable Format**
  - Data Structure Published in Metadata
  - Example: ISO/IEC 18025, Environmental Data Coding Specification
- **Model Accessibility**
  - Large: Remote Execution
  - Small: Downloadable Format
- **Time Management**
  - Revised IEEE 1516 (Series), High Level Architecture



# Conclusion

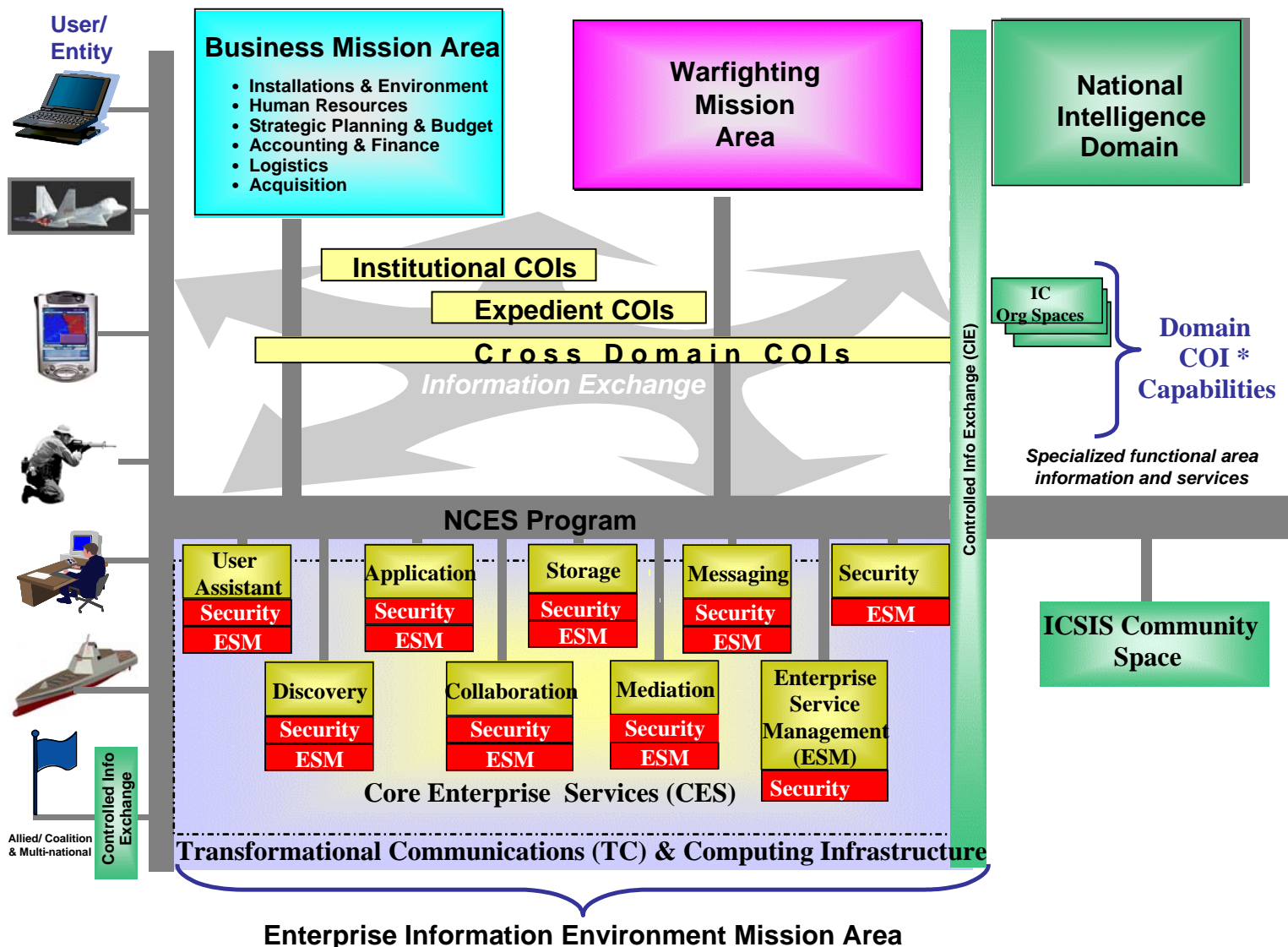
- **M&S on the GIG . . .**
  - **Is A Concept whose Time has Come**
    - ◆ Based on Commercial Technology
  - **Will Benefit Users and Developers**
    - ◆ Designers      ▼ Trainers
    - ◆ Analysts      ▼ Warfighters
  - **Information Assurance is a Major Hurdle**
    - ◆ Being Solved through Horizontal Fusion Demos and follow-on efforts



# BACK-UP SLIDES



# GIG Structure—Alternate View





# Gig Structure—Alternate View 2

